Geographic Differences in Semen Quality of Fertile U.S. Males

Shanna H. Swan,[1] Charlene Brazil,[2] Erma Z. Drobnis,[3] Fan Liu,[1] Robin L. Kruse,[1] Maureen Hatch,[4] J. Bruce Redmon,[5] Christina Wang,[6] James W. Overstreet,[2] and The Study for Future Families Research Group

[1]Department of Family and Community Medicine, University of Missouri-Columbia School of Medicine, Columbia, Missouri, USA; [2]University of California, Davis, California, USA; [3]Department of Obstetrics and Gynecology, University of Missouri-Columbia, Columbia, Missouri, USA; [4]Mount Sinai School of Medicine, New York, New York, USA; [5]Departments of Medicine and Urologic Surgery, University of Minnesota, Minneapolis, Minnesota, USA; [6]Harbor-UCLA Medical Center and Research and Education Institute, Torrance, California, USA

Although geographic variation in semen quality has been reported, this is the first study in the United States to compare semen quality among study centers using standardized methods and strict quality control. We evaluated semen specimens from partners of 512 pregnant women recruited through prenatal clinics in four U.S. cities during 1999–2001; 91% of men provided two specimens. Sperm concentration, semen volume, and motility were determined at the centers, and morphology was assessed at a central laboratory. Study protocols were identical across centers, and quality control was rigorously maintained. Sperm concentration was significantly lower in Columbia, Missouri, than in New York, New York; Minneapolis, Minnesota; and Los Angeles, California. Mean counts were 58.7, 102.9, 98.6, and 80.8 × 10^6/mL (medians 53.5, 88.5, 81.8, and 64.8 × 10^6/mL) in Missouri, New York, Minnesota, and California, respectively. The total number of motile sperm was also lower in Missouri than in other centers: 113, 196, 201, and 162 × 10^6 in Missouri, New York, Minnesota, and California, respectively. Semen volume and the percent morphologically normal sperm did not differ appreciably among centers. These between-center differences remained significant in multivariate models that controlled for abstinence time, semen analysis time, age, race, smoking, history of sexually transmitted disease, and recent fever (all p-values < 0.01). Confounding factors and differences in study methods are unlikely to account for the lower semen quality seen in this mid-Missouri population. These data suggest that sperm concentration and motility may be reduced in semirural and agricultural areas relative to more urban and less agriculturally exposed areas. *Key words:* **agriculture, geography, semen quality, sperm concentration, sperm morphology, sperm motility.** *Environ Health Perspect* **111:414–420 (2003). doi:10.1289/ehp.5927 available via *http://dx.doi.org/* [Online 11 November 2002]**

Historically, semen parameter studies have included highly selected and nonrepresentative subgroups such as compensated sperm donors, prevasectomy patients, or infertility clinic populations. Moreover, measures of semen quality are very sensitive to the methods of semen collection (including abstinence time) and analysis, which vary significantly among study sites. Further, most analyses of temporal trends and geographic variation in semen parameters have been retrospective and subject to confounding by factors such as smoking or recent high fever that cannot be well controlled retrospectively. These studies have been conducted almost exclusively at andrology centers, which are usually located in urban areas, primarily in Western Europe and North America.

Nonetheless, over the past decade several authors have reported large geographic differences between cities in mean sperm concentration. For example, an international study of testosterone-induced azoospermia found that mean pretreatment sperm concentrations of normal men in nine countries ranged from 52.1 × 10^6/mL in Bangkok, Thailand, to 103.5 × 10^6/mL in Melbourne, Australia [World Health Organization (WHO) Task Force on Methods of Regulation of Male Fertility 1996]. A wide range of sperm concentration was also reported in eight cities in France (Auger and Jouannet 1997). Several recent studies suggest that wide variation is also present among cities in the United States. Wittmaack and Shapiro (1992) examined sperm concentration between 1978 and 1987 in Madison, Wisconsin; mean sperm concentration during this time was approximately 80 × 10^6/mL. Paulsen et al. (1996) reported a geometric mean of about 50 × 10^6/mL in Seattle, Washington, during 1972–1993. A recent study in California (Fenster et al. 1997) found a median sperm concentration of 64 × 10^6/mL. Fisch and Goluboff (1996) reported large differences in mean sperm concentration in prevasectomy patients from Los Angeles, California; Minneapolis, Minnesota; and New York City, New York, with low concentration in Los Angeles compared with Minneapolis and New York City (72.7 vs. 100.8 and 131.5 × 10^6/mL, respectively). Because these retrospective studies used data collected under a variety of protocols, differences in population selection or methods of semen analysis may have contributed to these differences.

Recent multicenter studies have sought to eliminate many limitations of earlier studies by standardizing methods and populations. Recognizing that carefully controlled, prospective studies of semen parameters are needed, several multicenter national and international studies have been underway since 1997. The International Study of Semen Quality in Partners of Pregnant Women was recently completed in Europe (Jorgenson et al. 2001). This study found significant differences in mean sperm count and other semen parameters between fertile men recruited in Copenhagen, Denmark; Paris, France; Edinburgh, Scotland: and Turku, Finland. For example, sperm concentration in Copenhagen was only 74% that in Turku. The observed differences were not changed appreciably by adjustment for age, abstinence time, and season.

The ongoing Study for Future Families was designed in collaboration with the European study, so that meaningful comparisons can be made between U.S. and European

Address correspondence to S.H. Swan, Department of Family and Community Medicine, MA306 Medical Sciences Building, University of Missouri-Columbia, Columbia, MO 65212 USA. Telephone: (573) 884-4534. Fax: (573) 884-6172. E-mail: swans@health.missouri.edu

In addition to the authors, the Study for Future Families Research Group includes the following: B.S. Carter, D.J. Kelly, S.L. Stewart, and T.M. Simmons (University of Missouri); C. Treece (University of California-Davis); R.S. Swerdloff, L. Lumbreras, S. Villanueva, M. Diaz-Romero, A. Victoroff, R. Sandoval, S. Bravarian, A. Leung, and A.L. Nelson (Harbor-UCLA Medical Center); C. Hobel and B. Brock (Cedars-Sinai Medical Center, Los Angeles, CA); M. Pfeiffer, L. Quinones, K. Polgar, and A. Brembridge (Mt. Sinai School of Medicine); and C. Kwong, A. Muehlen, T. Perrier, T. Srb, J. Pryor, and C. DeJonge (University of Minnesota).

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